Australian Journal of Teacher Education

Volume 28 | Issue 2 Article 1

11-2003

Learning How to Learn : Problem Based Learning.

Wendy Hillman
James Cook University

LEARNING HOW TO LEARN: PROBLEM BASED LEARNING

Wendy Hillman
James Cook University

ABSTRACT

During the course of study for the Graduate Certificate of Education (Tertiary Teaching) we participated in a seminar about Problem Based Learning (PBL) and were asked to write a piece of assessment about this topic. I struggled long and hard with PBL and came up with a fairly mediocre piece of work to be assessed. This led me to an interest in PBL itself and, to the writing of this general overview of the subject. It has helped me to understand the concept and its implications within the tertiary system to a much greater degree.

Introduction

The tertiary sector has historically encouraged intellectualism and learning for its own sake. The main responsibility of higher education is to help students in their individual development of the capability to gain from, and to be able to embrace postmodernity and to contribute positively to their society in general (Bawden 1985: 43; Engel 1991: 23).

However, in recent decades, this model has come under attack. Knowledge should be connected to understanding. It needs to contain a distinct intention. Learners automatically make some sort of appraisal concerning how the expertise they are gaining, or the point of view they are learning about can be put into practice within their own personal lifeworld. A component of the educational procedure is being able to recognise what is common about what you are learning and then how you can correlate what is new to what you already understand (Bawden 1985: 44). It is retaining some versatility in your reasoning and being able to examine what others are submitting to you. It is being able to put yourself in diversified situations and investigate the outcomes of those situations (Mackenzie 1997: 394, Margetson 1994: 5). Hence, it follows that 'knowledge acquisition is in fact inductive' (Schmidt 1993: 422). That is, metacognition.

This advancement in learning underlines the quest for discovery. The learner appears to have to uncover new knowledge (Bawden 1985: 46), that is, knowledge that is new to the learner, even though it may be already known to the specialist. Therefore, Problem Based Learning (PBL) potentially can place the learner in a position similar to that of a scientist and scientific process (Kelly 1955; Woods 1985: 19). This is not unlike Popper's (1959: 49 - 56) argument in his work: *The Logic of Scientific Discovery*. This occurs through the discovery of new knowledge while undertaking a problem solving exercise. Therefore, discovery by learners is possible without it being a reckless unmanageable procedure (Aldred et al. 1997: 2; Margetson 1991: 46 – 49; Schmidt 1993: 423).

PBL is an advancement in vocational education that has been taken up in tertiary education at an undergraduate level in Australia, on the American continent and Europe within the last two decades (Boud 1985: 13; Coulson and Osborne 1984: 225). Numerous other Pacific and Asian countries are becoming aware of this approach to the education of potential professionals. Indeed, much pioneering groundwork has already been completed in the USA and the Netherlands. There is increasing pressure on the more traditional universities to adopt this approach (Boud

1985: 13), particularly at an undergraduate level. According to proponents of PBL, various circumstances are responsible for the implementation of PBL globally (Aldred et al. 1997: 2; Bligh 1995: 323; Schmidt 1993: 423). According to some writers in this field, a wealth of governing factors can be seen to have affected the increased implementation of PBL. Some of these include: a need to be more community oriented and in tune with community needs; distinguished shortfalls in 'traditional' specialist education; coping strategies for understanding the demands of the knowledge expansion in numerous sectors of expert scholarship; the need for experts to be able to adjust to responsibilities and impart knowledge clearly; and the need to appropriate expertise for lifelong scholarship (Aldred et al. 1997: 2).

PBL is defined by Ross (1991) as … the learning which results from the process of working towards the understanding of, or resolution of, a problem (Barrows and Tamblyn 1980, as cited in Ross 1991: 34).

Of course, some PBL can be mechanical in character; doomed only to train students to answer problems and obtain the knowledge needed for this. In these instances, the possibility for stimulation of deeper, all encompassing and formulated thought is misplaced through remedial problem solving avenues and methods; the chance for growth of individual and intercommunication proficiencies ceases to exist in ratio to badly chosen interference by staff, and intrinsic autonomous learning skills decrease through lack of stimulation by teachers who find it difficult to defy the urge to give of their knowledge and insight (Drinan 1991: 316). However, there is also a positive side to PBL. Some of the positive aspects of PBL are learning advances centred on the students, less learning centred on the teachers, a class based variation in common learning topics which includes both the continuity and range of learning (Neufeld 1984: 65).

One of the purposes of PBL over and above established procedures of teaching is that it clearly identifies and values previous learning. With the problem based approach, which includes 'problem exploration', information searches and 'synthesis' of the information uncovered (Neufeld 1984: 69), establishing the tutorial synopses relies on students pinning down the issues and building a reply to them without any former organised reading or contribution from specialists (Boud 1985: 13). In this way, students have a chance to use their processed knowledge and encounters and this prior learning is highly regarded and valued, both by staff and other students. This gives mature aged students, especially, a chance to contribute and so, achieve self-assurance in their scholastic aptitude (Aldred et al. 1997: 3; Lee 1997: 107; Norman and Schmidt 1992: 559).

What Constitutes PBL?

Fogarty (1997) defines PBL as 'a curriculum model designed around real life problems that are ill structured, open ended or ambiguous' (Fogarty 1997: 2), and further, suggests that 'PBL engages students in intriguing, real and relevant intellectual inquiry and allows them to learn from these life situations' (Fogarty 1997: 2).

The fundamental premise basic to PBL is that the beginning point for learning should be a problem that the learner wants to resolve (Boud 1985: 14). Subjects and courses are created and taught using problems as the motive and chief focus of the student activity. These problems or predicaments are grounded in a specialist model, rather than on formal wisdom from professionals. PBL is especially pertinent for professionally aligned subjects because it eschews the theory/practice polarity, the two being linked from the outset (Lee 1997: 104).

Within the PBL philosophy, the term 'problem' should be recognised to be confining in itself. It is an inadequate representation for the situations which are appropriate for study in numerous occupations (Woods 1985: 20). The point is that the word 'problem' suggests being responsible, when the locus may require action – and therefore, include an investigation of an extensive area and engagement of different approaches (Drinan 1991: 317). At a fundamental level, PBL is a theory of knowledge, schooling and comprehension – ie learning - highly different from the customary concept at the foundation of subject or course organised learning (Margetson 1991: 43 – 44; Woods 1985: 19).

PBL constitutes a problem to be solved. There are many differences between an ill structured and a well-structured problem. Instruction about problem solving in the classroom is a process whereby students are presented with a problem and it is solved by the end of the lesson. This is different from professional problem solving where the problem is the first point of contact and leads to investigation and knowledge. PBL gives students the chance to experience professional style ill structured and pragmatic problems. The curriculum and design of PBL allows students to experience the professional problem solver position through the design of instruction surrounding the investigation of an ill-structured problem. Instead of acting as experts with the correct answers, tutors act as coaches and facilitators of independent learning regarding the problem in question (Stepien, et al. 1998: 143).

In PBL, as in traditional forms of learning, teachers provide information to create opportunities for students to learn. Teachers also support and guide students' learning through scaffolding instruction to enable management of learning tasks. Further, in PBL, students are encouraged to use metacognition in learning so teachers can assess learning difficulties and dilemmas, provide feedback and offer evaluation (Blumfeld et al. 1998: 116). Therefore, scaffolding is essential for students who do not readily apply themselves well to utilising thinking strategies (Blumfeld et al. 1998: 119). Scaffolding is also an element of PBL that distinguishes it from discovery learning. Within the scope of PBL problems should be given to the students to solve. Giving students exercises is not the same as providing them with problems. Therefore, the students progressing through a PBL session need to be able to solve problems. But, this does not indicate that because problems have been provided for students that problem solving is actually taught. In fact, a misconception of this mode of teaching is that problem solving and PBL are one and the same. This is not correct. Problem solving is not necessarily enhanced by the use of PBL (Boud 1985: 23).

There is an important educational approached used in PBL. This approach requires that the students work on the problems presented to them in order to gain the basis and grounding they need to pursue the problem itself (Boud 1985: 15; Jones et al. 1984: 182). This inverts the usual patterns of problem solving found in universities and undergraduate courses throughout the world. Normally, one would assume that the students already have the knowledge within their grasp before they begin to solve a given problem (Woods 1985: 23). With PBL, the knowledge is acquired through working on the problem itself (Bligh 1995: 323; Ross 1991: 36; Schmidt 1993: 428; Woods 1985: 19).

PBL is frequently presented to students through a non-fictional scenario. This can be any number of things from an article in a journal, a piece of factual information, an argument in a shortened form, or a short representation of a scenario. Once the scenario has been presented to the students,

they control the path the exploration takes (Fogarty 1997: 2).

PBL highlights the ability of students to acquire propositional knowledge, if and when they need to, and then, enables them to apply this knowledge in a given scenario. Thus, it follows that, PBL does not negate the significance of content, but it does not hold with the idea that content is ideally gained in the abstract, in large chunks, and memorised by rote, therefore, leading to usage and application at some later date to specific problems (Margetson 1991: 44).

At the commencement of a PBL learning activity, students are introduced to a problem or scenario. This, in itself, helps to establish an appropriate context for learning. Basically, it permits students to question, as individuals, concerns about why the problem is happening, what the sequence of events are, and how to go about finding a solution to the problem. Thus, in a PBL scenario, students accumulate information so as to be able to comprehend the problem in full, and therefore, possibly to resolve it (Coles 1991: 301, Norman and Schmidt 1992: 557). Crebbin (1997), in her article on using PBL in teacher education courses, supports this line of thinking by arguing:

For a lot of students, this is the first time in their life they have been left on their own to work out the group interaction. They are given support, but a lot of it is left up to them. So the process of working out how to make sure everybody is doing an equal amount of work is something they work out and address as an issue alongside getting the results required by the commission (Crebbin 1997: 144; italics in original).

Exponents of PBL argue that the process by which students learn is of critical importance in helping them to conduct themselves appropriately in their future professions, and that they will acquire the information they need as they need it (Boud 1985: 16; Coulson and Osborne 1984: 225; Drinan 1991: 318; Woods 1985: 23).

Curriculum

Curricula with a problem base more often than not give emphasis to communications skills in tutorial groups, acceptance of accountability for learning, learning to learn, pertinent preference and use of a broad expanse of learning resources, and evolvement of problem solving proficiencies (Bligh 1995: 325; Swanson et al. 1991: 262). This is evident where students have not yet acquired these skills.

Where PBL has been taken up as the base for the curriculum, its utilisation is supposed to perform two separate purposes. The first is to use PBL as a method that will help students achieve a certain set of goals, and to help them become proficient in a particular group of capabilities. The second purpose is to use PBL as their preferred choice, as it is relevant and appropriate to sustain the conditions that motivate effective adult learning (Engel 1991: 24 – 25; Norman and Schmidt 1992: 558).

PBL is therefore particularly suited to help students become proficient in a range of separate capacities and to aid active adult learning in the intellectual and predominant aspects of a course at university level. Nevertheless, the full potential of PBL as an academic approach is dependent on the outline of the curriculum (Engel 1991: 29). PBL can be implemented right across the curriculum where it leads to form of more independent learning. The problem based synopsis lays down an extensive student exploration that is flowing, energetic, adaptable and always developing (Fogarty 1997: 2; Norman and Schmidt 1992: 558).

The form in which problems could be administered to students would normally be; a trigger, a statement describing a particular scenario, or a group of questions (Aldred et al. 1997: 49; Margetson 1994: 6;

Ross 1991: 37). This would then be followed by other types of presentations such as: 'written descriptions' and other simulated aids regarding the trigger statement and possible scenario. The students would then spend the remaining time in the tutorial exploring the problem. This would inevitably lead them to another set of interconnected questions (Margetson 1994: 6). Throughout the semester students build, retain and enhance their knowledge on the specific problem. By semester's end they have acquired a large knowledge base and comprehension of the various facets of the problem under investigation (Margetson 1994: 6).

The tutors within the PBL model take on the role of a facilitator (Bawden 1985: 53). They only contribute to discussion and other parts of the tutorial by introducing the new trigger, set of questions or the particular scenario (Aldred et al. 1997: 4; Fogarty 1997: 9; Schwartz 1991: 69). The behaviour of the tutor can have a direct significance on group purpose and an oblique effect on the learner's attention to the subject content. Therefore, tutors need to have a sophisticated and diverse collection of proficiencies and to be able to formulate a unique relationship with students. This makes the tutor a promoter, resource individual, group operator, role exemplar, assistance individual, miscreant, supervising director and appraiser (Aldred et al. 1997: 5).

Evaluation of accumulated knowledge is often of interest within PBL curricula, because this type of knowledge evolves over an extended length of time in answer to experience in the genuine problem solving setting (Swanson et al. 1991: 265).

Utilising PBL

A particular advantage of PBL is that it sustains an intimate attachment between theory and practice, because knowledge growth is always happening in a practice circumstance. This evades the necessity to toil over combining theory and practice because the two are connected from the start. In the conventional format, students acquire a high regard of theory and then have to work out how that is exercised in the field. In the PBL context, students start with a practice foundation and the theory grows out of the practice (Lee 1997: 104; Margetson 1994: 6).

The most outstanding change brought about by introducing PBL is that of the role of the facilitator, either tutor or teacher. It can often lead to dissatisfaction with teaching and their self-esteem as lecturers or teachers. It is very often a hard road to travel. The lecturers who have a good track record of teaching and presenting in the 'old' style of lecturing, find it relatively hard to adjust to the new style (Bligh 1995: 323; Fogarty 1997: 3; Margetson 1994: 3; Todd 1991: 132). This is reflected in new attitudes to the way teachers teach and direct the students' learning and, to the traditional methods of standing in front of a class or lecture and delivery information didactically.

Another major adjustment to be made is on behalf of the students. Although they may agree in principle with the entire idea of PBL, it may well be in total conflict with their previous experiences of learning. This is particularly true for recent school leavers, who may actively resist attempts to teach them the new form of curriculum, until they realise that they are actually acquiring learning skills successfully, in this manner (Boud 1985: 18; Fogarty 1997: 7; Neufeld 1984: 64; Todd 1991: 133). Finally, another area of conflict arises from colleagues who react negatively to the use of PBL. This is particularly a problem when only a small number of lecturers or individuals advocate the use of PBL and the rest of the School or Faculty adheres to traditional lecturing techniques (Todd 1991: 133). Many negative reactions can be experienced by the supporters of PBL. These may include: total lack of interest on the part of colleagues; and, lack of support

or patronising behaviour because PBL can be perceived as a threat to 'normal' teaching practices and paternalist and hierarchical teaching modes (Todd 1991: 133).

From the viewpoint of the student, the experiences associated with PBL are essential to helping the lecturers comprehend the reality associated with PBL. But, the experiences alone are not enough to bring about changes in attitude or perceptions (Todd 1991: 134). Indeed, endeavours have been undertaken to illustrate a theoretical basis for PBL, but these have had to rely much too heavily on differing theoretical structures that are in need of coherence. Frequently lecturers use analogies as a way of illustrating otherwise hypothetical arguments. This, in itself, depicts an attempt to place learning in a meaningful context (Coles 1991: 297 – 299; Norman and Schmidt 1992: 563).

Learning to employ broad principles in problem solving circumstances is greatly significant, with minimum instruction provided by tutors and utmost opportunity for investigation by students (Swanson et al. 1991: 261). By its very character, the sort of facts students are being taught, and which they are supposed to learn, are doubtless to be of a hypothetical kind. Alone, it probably bears little significance for many students. But, this is knowledge which students are expected to obtain to help them function efficiently (Coles 1991: 299). According to Crebbin (1997):

So what we are actually doing is creating a situation in which students are seeking knowledge rather than just being given it (Crebbin 1997: 142; italics in original).

It is also evident that the puzzle or scenario may not always contribute a suitable context for learning, and there is some indication that this can happen to the detriment of students' knowledge acquirement. Ideally, scenarios should be personally meaningful. This is where the 'trigger' is used as a 'hook' to interest the students. Furthermore, in PBL, students are frequently required to obtain the information for themselves, but under particular circumstances it might be fitting to make the information accessible to students. Likewise, the problem solving mechanism in PBL can, but do not necessarily, afford an opportunity for managing the information in such a way that elucidation happens for all the students in question. Consequently, though PBL might perfectly seem to mirror the three fundamental attributes of the contextual learning archetype, it might not do so if a definite attempt were not made to guarantee that these actions do really eventuate (Coles 1991: 302).

An added strength of PBL is that it encourages student controlled learning. Rather than counting on staff for handouts and direction, the students ascertain for themselves how to deal with the topics. This provides them with a better sense of direction over their own learning. Students are much more responsive to learning when they recognise their own learning requirements than when they are told what their learning requirements are. They assuredly seem to be much more resigned to working on the problem and locating information when they have prioritised their own needs. One of the reasons PBL is so popular is that students consider they have more power. Boud (1987) notes

The student works with the problem in a manner that permits [their] ability to reason and apply knowledge to be challenged and evaluated. Appropriate to [their] level of learning ... Needed areas of learning are identified in the process of work with the problem and used as a guide to individualised study (Boud 1987: 14).

This is at odds with the mainstream approach where the final say lies with the lecturer who fixes the boundaries of what students need to know, endeavours to ensure they comprehend it, and then

examines it to find out whether or not they have retained it (Fogarty 1997: 7; Margetson 1994: 9; Lee 1997: 108).

A message of warning is essential here. For the PBL philosophy to be successful, staff concerned need a specific scope of characteristics, not perhaps existing in all university academic staff. This form of teaching requires staff to have a moderate level of self reliance, to be able to associate comfortably with students on a one to one level, to envisage students as counterparts and therefore able to make judgments for themselves, and to approve of student decisions. Those who support the 'tabula rasa' example of education or who need to be the centre of focus may not freely adjust to PBL. How one conquers that dilemma, especially where there is no option about instructional personnel, will certainly be an important role for staff progress (Lee 1997: 115).

Also, a major problem that seems to surface during the implementation and organisation of a PBL course, is that providing this type of course puts many demands upon the staff. Some of these demands include added time and resource factors, skill requirements as facilitators rather than lecturers, commitment to this method of learning, flexibility and collaboration with others (Aldred et al. 1997: 5, 40, 59). Added to this, are the current trends that value research over teaching (Johnston 1997: 444).

Assessment

Although the curricula of PBL are based upon premises that the learning process is emphasised, the students are responsible for their own learning, and also, PBL is considered a preparation for 'lifelong learning'. There are many salient diversities between PBL programs that have implications for evaluation (Swanson et al. 1991: 261). As Lee (1997) argues:

The assessment encourages the students to develop their understanding of the theory. Many of them would not look too closely at the theory if the assessment activities, such as writing essays, did not push them to do so (Lee 1997: 112).

Self, group and tutor evaluations are frequently used to rate a wide range of skills (Jones et al. 1984: 195). These would commonly include: endeavour, self-guided learning, teamwork and communication proficiency. Use of self-assessment fits perfectly with PBLs stress on examining the condition of self knowledge as a fundamental component of learning procedure (Swanson et al. 1991: 262). However, as Johnston (1997) states in his article on teaching PBL within the discipline of Architecture at the University of Newcastle, Australia:

When you set students on a problem solving course, they don't know what to do at first. You have to provide facilities so they can find out information to solve their problems (Johnston 1997: 442).

The efficacy of the course relies upon details of the composition and formulation of knowledge and proficiency that sustain the PBL process (Neufeld 1984: 70), not in the crude specifics of the program itself. Ownership of specific knowledge of an area does not ensure successful application of that knowledge in the resolution of problems. Indeed, this is a primary component in the rationale for PBL knowledge: knowledge is better retained in the way it was learned in the first place (Swanson et al. 1991: 264).

It can be exceedingly easy in problem based subjects for students to be convinced that they are simply required to resolve a problem and so speculate their progress from problem to clarification without solemnly engaging either sources of knowledge or intellectual facilities (Neufeld 1984: 70). This lack of application should become evident in student evaluation if that evaluation plainly follows the aims of the curriculum. That it

occasionally fails to do this is a special illustration of the lack of acknowledgment of the need for clear approaches to assessment in PBL, and of the dilemma in innovating such approaches (Drinan 1991: 318). A problem-based scenario brought to finalisation is identified by the students' activities. Initially they work on the problem by researching information on the given topic. A synthesis of the information acquired is then presented by the students to the tutor. Self-assessment by the students forms part of the final analysis, as does feedback from the tutor. Final grades, for that particular assessment, are then awarded (Neufeld 1984: 68). Individual differences are now the focus of research rather than the outcomes of learning goals associated with teaching practices and classroom environments. Promotion by teachers of learning and inquiry in a conducive environment promotes a focus on learning and not on individual ability (Blumenfeld et al. 1998: 117). Primarily, the perspective is that teaching entails learning. (Blumfeld et al. 1998: 128).

Conclusion

Successful execution of PBL does not come effortlessly (Todd 1991: 135). PBL is not a way of teaching and learning that can be adopted and then discarded as another passing phase (Bligh 1995: 325). It can be thought of as a way of taking higher education into the future. The bonus from this mode of teaching comes from the intellectual stimulation provided by the energetic levels of motivation and eagerness of the students in such a curriculum (Coulson and Osborne 1984: 229; Engel 1991: 31).

PBL does not dispute aptitude; rather it is a way of accumulating a particularly significant type of expertise. Neither does it negate the significance of subject material, or makeup. Rather, it locates content in a dynamic perspective which makes it accessible to the students concerned (Margetson 1991: 50).

In some cases, the implication may be that PBL is an unnecessary complication to the educational scene. It has been an interesting and worthy experiment but now we know about the contextual learning model we no longer need to reinvent it. Certainly, courses designed around mainstream, conventional forms of teaching should not be abandoned in favour of PBL courses. Rather, they should be helped to evolve in line with the principles of contextual learning outlined here (Coles 1991: 305).

Exemplary teaching is about constructing an atmosphere where learners sense that they can learn, that they can make decisions about their education and be accountable for their learning, and that they can be successful. Exemplary teaching must consist of eagerness and responsibility in the lecturer's role. It takes time, stamina and responsibility to have confidence that understanding is taking place. It cannot be assumed that by presenting mountains of content it will automatically be synthesised. The supposition that simply delivering masses of content is competent teaching is most likely quite prevailing in the tertiary environment. This could be perceived as a concern. Students recognise if their lecturers have regard for their levels of learning (Crebbin 1997: 149). Poor teaching can be seen as anything that bores and alienates the students (Dottin and Weiner 2001). Alienation can come from the experience of being 'taught at' through the use of lectures and teacher directed tutorials. Students often find certain types of assignments and other 'normal' curricula assessments boring. PBL does not lend itself to boredom. The students are too busy and so, do not have time to think about being bored or alienated (Johnston 1997: 444).

Finally, it is apparent that because of the complex educational approach demanded by the use of PBL, the process of designing

and using suitable assessment methods requires a substantial and continuing effort. This effort needs to receive high priority by educational institutions, because it is well worthwhile (Neufeld 1984: 70).

References

Aldred, S., Aldred, M., Walsh, L. and Dick, B. (1997) *The Direct and Indirect Costs of Implementing Problem Based Learning into Traditional Professional Courses within Universities* Australia: AGPS.

Bawden, R. (1985) 'Problem-based Learning: An Australian Perspective' in Boud, D. (ed.) *Problem-Based Learning in Education for the Professionals* Australia: HERDSA.

Bligh, J. (1995) 'Problem-based Learning in Medicine: An Introduction' *Postgraduate Medical Journal* 71: 323 – 326.

Blumenfeld, P., Soloway, E., Marx, R. Krajcik, J., Guzdial, M. and Palincsar, A. (1998) 'Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning' in Fogarty, R. (ed.) *Problem Based Learning: A Collection of Articles* USA: Skylight Training and Publishing Inc.

Boud, D. (1985) 'Problem-based Learning in Perspective' in Boud, D. (ed.) *Problem-Based Learning in Education for the Professionals* Australia: HERDSA.

Coles, C. (1991) 'Is Problem-based Learning the Only Way?' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Coulson, R. and Osborne, C. (1984) 'Insuring Curricular Content in a Student-directed Problem-based Learning Program' in Schmidt, H. and de Volder, M. (eds) *Tutorials in Problem-Based Learning* The Netherlands: Van Gorcum and Co.

Crebbin, W. (1997) 'Teaching for Lifelong Learning' in Ballantyne, R., Bain, J. and Packer, J. (eds) *Reflecting on University Teaching: Academics' Stories* Australia: AGPS.

Dottin, E. and Weiner, M. (2001) *Enhancing Effective Thinking and Problem Solving for Preservice Teacher Education Candidates and Inservice Professionals: Case Study Analysis* Maryland, USA: University Press of America Inc.

Drinan, J. (1991) 'The Limits of Problem-based Learning' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Paul.

Engel, C. (1991) 'Not Just a Method But a Way of Learning' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Fogarty, R. (1997) *Problem Based Learning and Other Curriculum Models for the Multiple Intelligences Classroom* Australia: Hawker Brownlow Education.

Gallagher, S. and Stepien, W. (1998) 'Content Acquisition in Problem-Based Learning: Depth Versus Breadth in American Studies' in Fogarty, R. (ed.) *Problem Based Learning: A Collection of Articles* USA: Skylight Training and Publishing Inc.

Johnston, L. (1997) 'Expedition of Discovery: Architectural Education at Newcastle' in Ballantyne, R., Bain, J. and Packer, J. (eds) *Reflecting on University Teaching: Academics' Stories* Australia: AGPS.

Jones, J., Bieber, L., Echt, R., Scheifley, V. and Ways, P. (1984) 'A Problem-based Curriculum – Ten Years of Experience' in Schmidt, H. and de Volder, M. (eds) *Tutorials in Problem-Based Learning* The Netherlands: Van Gorcum and Co.

Kelly, G. (1955) *The Psychology of Personal Constructs* Vols. I and II New York: Norton.

Lee, P. (1997) 'From Control to Trust – A Case Study of Problem-based Learning' in Ballantyne, R., Bain, J. and Packer, J. (eds) *Reflecting on University Teaching: Academics' Stories* Australia: AGPS.

Mackenzie, L. (1997) 'Putting Occupational Therapy into Practice' in Ballantyne, R., Bain, J. and Packer, J. (eds) *Reflecting on University Teaching: Academics' Stories* Australia: AGPS.

Margetson, D. (1991) 'Why is Problem-based Learning a Challenge?' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Margetson, D. (1994) *Current Educational Reform and the Significance of Problem-based Learning*, Occasional Papers, Publication No. 1, Queensland: Griffith University.

Neufeld, V. (1984) 'The Design and Use of Assessment Methods for Problem-based Learning' in Schmidt, H. and de Volder, M. (eds) *Tutorials in Problem-Based Learning* The Netherlands: Van Gorcum and Co.

Norman, G. and Schmidt, H. (1992) 'The Psychological Basis of Problem-based Learning: A Review of the Evidence' *Academic Medicine* 67 (9): 557 – 565.

Popper, K. (1959) *The Logic of Scientific Discovery* New York: Harper and Row.

Ross, B. (1991) 'Towards a Framework for Problem-based Curricula' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Schmidt, H. (1993) 'Foundations of Problem-based Learning: Some Explanatory Notes' *Medical Education* 27: 422 – 432.

Schwartz, P. (1991) 'Persevering With Problem-based Learning' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Stepien, W., Gallagher, S. and Workman, D. (1998) 'Problem-Based Learning for Traditional and Interdisciplinary Classrooms' in Fogarty, R. (ed.) *Problem Based Learning: A Collection of Articles* USA: Skylight Training and Publishing Inc.

Swanson, D., Case, S. and van der Vleuten, C. (1991) 'Strategies for Student Assessment' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Todd, S. (1991) 'Preparing Tertiary Teachers for Problem-based Learning' in Boud, D. and Feletti, G. (eds) *The Challenge of Problem Based Learning* London: Kogan Page.

Woods, D. (1985) 'Problem-based Learning and Problem Solving' in Boud, D. (ed.) *Problem-Based Learning in Education for the Professionals* Australia: HERDSA.